

REMARKS

The above-identified patent application has been amended and entry of this Amendment is respectfully requested in accordance with the provisions of 37 C.F.R. §1.116.

Claims 1 to 18 are pending in the application. Claims 11, 13 and 15 are amended herein and claims 16-18 are added.

Claims 13 and 15 have been amended in order to correct an inadvertent lack of antecedent basis for "the selected physical device," as pointed out by the Examiner.

The Examiner has again rejected Claims 1-15 as being anticipated by or, in the alternative, as being obvious over Mason, Jr. et al. (U.S. Patent No. 6,112,257, hereinafter "Mason, Jr.") in view of Saether et al. (U.S. Patent No. 5,333,315, hereinafter "Saether"). Applicants respectfully traverse this rejection and maintain that neither Mason, Jr. nor Saether, whether taken separately or in combination, describes or suggests "determining from the statistics n most active of the physical devices and for each of the n most active of the physical devices, adjusting a mirror service policy associated with one or more mirrored logical volumes serviced by the physical device to reduce seek time," as set forth in claim 1 or similarly in claim 10. Applicants have amended claim 11 to specify that the storage controller determines from the statistics n most active of the physical devices and respectfully submit that neither of the cited references, whether taken alone or in combination, describes or suggests the claimed controller that "determines from the statistics n most active of the physical devices and, for each of the n most active physical devices, adjusts a mirror service policy associated with a mirrored logical volume serviced by the physical device to minimize seek ..." as set forth in claim 11.

As Applicants previously pointed out in the Response dated May 24, 2004, Mason, Jr. "sorts logical volumes by activity level, load balances the physical devices based on the activity levels of the logical volumes and minimizes seeks for the logical volumes on the same physical devices." (see Background of the Invention section). Significantly, and as described on page 21, lines 13-17 of the specification and as is illustrated in Fig. 7, "[B]ecause the old scheme has to

perform a sort for and evaluate all physical devices logical volume by logical volume, it can only make response time improvements... at intervals of time 't'." In contrast, the claimed method "which evaluates only the n busiest of the physical devices and therefore performs policy updates at a much greater frequency (for example, every 20 seconds), adjusts more quickly to changes in system workload for better response time results." (see the specification at page 21, lines 18–22). Thus, the claimed arrangement provides an advantage in terms of response time which is neither described nor suggested by Mason, Jr., whether considered alone or in combination with Saether.

Regarding the Examiner's position that the claims are anticipated by Mason, Jr., the Examiner states that Mason, Jr., discloses "collecting statistics for the physical devices (see Figs. 5E, 5I, 5K, 5P, 5T, etc.), determining n most active devices (since the table records the activity for each drive, it determines to the extent claimed which are the n most active, see also Fig. 4B item 230)..." (Final Office Action dated December 15, 2004, page 3, paragraph 7, emphasis added). The Examiner further states, on page 5, paragraph 11 of the Final Office Action that "[T]he claim does not require identification of which devices are the n most active, or indication of which are the n most active, only 'determining n most active'. Because Mason determines the physical activity level of all drives (e.g., Fig. 5E), Mason 'determines n most active'."

The Examiner thus appears to liken the claimed "determining n most active devices" to Mason, Jr.'s teaching of populating a table such as is shown in Figure 5E, which table contains activity levels of physical devices. However, Applicants respectfully point out that claim 1 requires "determining from the statistics n most active of the physical devices," which statistics are collected for each of the physical devices, as is further specified in claim 1. Thus, a full and fair reading of claim 1 in light of the specification reveals that "determining from the statistics n most active of the physical devices" requires something beyond collecting statistics for the physical devices; namely, it requires an affirmative determination of or, stated differently, ascertaining, *from collected statistics*, which of the physical devices are the n most active. It is thus inappropriate to liken populating a table with statistics including activity levels for physical

devices by Mason, Jr. to the claimed “determining from the statistics n most active of the physical devices.”

In view of the above, it is submitted that independent claims 1, 10 and 11 are novel over Mason, Jr.

Regarding the Examiner’s position that the claims alternatively are rendered obvious by Mason, Jr. in view of Saether, the Examiner states that “Mason, Jr. does make a determination of the n most active logical volumes (see col. 5 line 16-21), but regarding devices only determines the activity of all devices.” (Final Office Action dated December 15, 2004, page 3, paragraph 7). The Examiner relies on Saether as teaching that “it was well known at the time that monitoring the load of and balancing amongst physical devices would benefit overall system performance ... and that [T]his balancing necessarily requires identifying the n most active devices... .” The Examiner concludes that “the teaching that physical devices should be monitored and balanced for optimum performance... combined with the teaching that using the n most active elements most directly optimizes without overextending processing and storage required therefor, would have motivated an artisan to determine the n most active devices in Mason, Jr.” Applicants respectfully traverse this rejection for several reasons as follows.

Saether neither describes nor suggests “for each of the n most active of the physical devices” (or, in fact, for any physical devices), “adjusting a mirror service policy associated with one or more mirrored logical volumes serviced by the physical device,” as set forth in claim 1 or similarly in claim 10, or the storage controller that “for each of the n most active of the physical devices, adjusts a mirror service policy associated with a mirrored logical volume serviced by the physical device,” as set forth in claim 11. Rather, Saether describes “monitoring disk I/O loads and disk capacity and to automatically move files between disks so as to balance either disk loads or disk capacity or both.” (col. 6, lines 40 – 45).

In this regard, the Examiner states that “[T]he movement of files amongst disks to improve performance as taught by Saether is analogous to the adjustment of mirror service

policy used by Mason, Jr., because the latter changes the disks that are accessed in a similar manner, except that files need not be moved as in Saether since copies thereof already exist at the mirrors.” (Final Office Action, page 4, paragraph 7). Applicants respectfully disagree and submit that adjustment of a mirror service policy is not “analogous” to the “movement of files amongst disks” and in fact, does not involve the movement of files amongst disks. A mirror service policy is an attempt to optimize operations associated with mirrored logical volume pairs. The existence of mirrored logical volumes presents load balancing constraints not present when logical volumes are not mirrored. For example, load balancing according to Saether may be achieved by comparing device capacities and moving files amongst devices in an effort to equalize capacities. However, in a mirrored logical volume arrangement, response time is not improved by moving files amongst devices. Rather, it is necessary to find an optimum way to service requests for the mirrored logical volumes. For example, and as described in Applicant’s Background section, “[O]ne such policy is to only service requests that fall within the first half of a logical volume on one of a mirrored pair of physical devices and the requests to the second half of the logical volume on the other, mirrored physical device. Another policy might be to only service requests that fall in odd groups with a group being defined in terms of a number of blocks.”

Furthermore, Applicants respectfully submit that there is no motivation to combine the cited references in a manner to arrive at the claimed arrangement for several reasons. First, Mason, Jr. is concerned with minimizing seeks for the logical volumes on the same physical devices in a mirrored logical volume arrangement; whereas Saether is concerned simply with disk I/O load and capacity monitoring and balancing. Thus, one of ordinary skill in the art seeking to solve the problem solved by Mason, Jr. would not look to the teaching of Saether for a solution or an improvement.

In this regard, the Examiner states “each is concerned with optimizing performance in a multi-disk system and an artisan would have sought to combine any teachings that might be derived therefrom in any multi-disk system.” (Final Office Action, pages 5 and 6, paragraph 13). Applicants respectfully point out that load balancing in a system with a mirrored logical volume

arrangement is a distinctly different endeavor with different considerations and constraints than load balancing which can be achieved by moving files amongst disks, as in Saether. As such, it is maintained that one of ordinary skill in the art seeking to solve the problem solved by Mason, Jr. would not look to the teaching of Saether for a solution.

Furthermore, there is no recognition in the prior art of the problem solved by Applicant's invention; namely of performing mirror service policy updates at a much greater frequency and adjusting more quickly to changes in system workload for better response time results. (see Specification at page 21, lines 18-22). Thus, one of ordinary skill in the art considering Mason, Jr., even in combination with Saether, would not be alerted to the possibility of an improvement in the response time results in a dynamic mirror service policy and so, such recognition would not provide the lacking motivation to combine the references.

Moreover, even if one of ordinary skill in the art were motivated to combine the teachings of Mason, Jr. and Saether, the claimed arrangement would not result. This is because Saether teaches that the disks should be monitored in terms of capacity and I/O loads and files should be moved to balance the disk capacity and the disk loads. Modifying Mason, Jr. to include this function would not impact the manner in which Mason, Jr. dynamically adjusts the mirror service policy by collecting statistics regarding the logical volumes of the system disks, and determining from the collected statistics whether the mirror service policy should be changed. In other words, even assuming *arguendo* that some motivation did exist to combine the teachings of the Mason, Jr. and the Saether references, the claimed arrangement would not result.

In view of the above, it is submitted that independent claims 1, 10 and 11 are not obvious over Mason, Jr. in view of Saether.

Claims 2-9 are dependent on claim 1 and thus, include the limitations of claim 1. Claims 12-13 are dependent on claim 10 and thus, include the limitations of claim 10. And claims 14-15 are dependent on claim 11 and thus include the limitations of claim 11. Accordingly, it is submitted that claims 2-9 are patentable over Mason, Jr., at least for the reasons discussed in

conjunction with claim 1, that claims 12-13 are patentable over Mason, Jr., at least for the reasons discussed in conjunction with claim 10, and that claims 14-15 are patentable over Mason, Jr., at least for the reasons discussed in conjunction with claim 11.

It is submitted that claim 3 is further patentably distinct over the cited references since neither reference describes or suggests using a cost function analysis to determine that workload assigned to one or more selected mirrored logical volumes according to a current mirror service policy can be re-assigned to a corresponding mirrored copy according to a new mirror service policy, as set forth in claim 3.

Claim 5 is also further patentable over the cited references since neither reference, whether considered separately or in combination, describes or suggests computing cost functions for each of the physical devices involved in the cost function analysis and determining a maximum value from the computed costs functions, based on the current mirror service policy and a new mirror service policy, as set forth in claim 5. Nor does either cited reference contemplate determining that the reassignment of workload can be made if the maximum value based on the new mirror service policy is less than the maximum value based on the current policy, as set forth in claim 6.

Claims 7 and 8 are further patentable over the cited references since neither reference describes or suggests that adjusting comprises processing the one or more logical volumes in a sequence beginning with the outermost logical volume bordering logical volumes serviced by another physical device, as set forth in claim 7. Nor does either references describe or suggest wherein, for each successive processed logical volume, the new mirror service policy of an immediate predecessor of the processed logical volumes is used as the current mirror service policy for the cost function analysis, as set forth in claim 8.

It is submitted that claims 12 and 14 are also further patentably distinct over the cited references since neither reference describes or suggests adjusting the mirror service policy in response to simulation of a new mirror service policy. In this regard, the Examiner states that

“[A]ny processing that occurs to implement a new mirror service policy, before it is actually implemented, may be considered the simulation to the extent claimed.” (Final Office Action dated December 15, 2004, pages 4 and 5, paragraph 9). Applicants respectfully disagree and point out that regarding the simulation set forth in claims 12 and 14, it is described starting at page 15, line 15 of the specification that “[A]t this stage, and as indicated above, the process is merely simulating the change, that is, the reassignment has not actually been implemented by recording the policy ‘swap’ in the DMSP tables 82... .”

Claims 13 and 15 are also believed to be further patentably distinct over the cited references since the references neither describe nor suggest the claimed arrangement wherein the mirror service policy is adjusted in response to a cost function analysis of a selected one of the n most active physical devices as a result of a current mirror service policy and a cost function analysis of the selected physical device as a result of the new mirror service policy. In this regard, the Examiner states that the “cost function analysis is disclosed in Mason as the use of the collection of data shown in Figs. 5.” (Final Office Action dated December 15, 2004, page 4, paragraph 9). Applicants respectfully request clarification and point out that Mason, Jr. uses Figures 5 to illustrate an example that is described starting in column 7. Specifically, Figures 5 illustrate a comparison of activity levels “for the decision about which physical device is preferred (between the two which can be chosen).” (col. 7, lines 46-48).

Applicants have added new claims 16-18, which are dependent on claims 1, 10, and 11, respectively. Support for claims 16-18 is found, for example, on page 13, lines 15-19 and in Figure 4. Claims 16-18 are believed to be patentable as being dependent on patentable base claims for reasons discussed above. It is further submitted that neither Mason, Jr. nor Saether describes or suggests the feature of claims 16-18, comprising sorting the n most active of the physical devices by activity level and wherein the mirror service policy is adjusted for each of the n most active of the physical devices in the sorted order.

As the claims and the entire case are believed to be in condition for allowance, an indication thereof is respectfully requested.

It is submitted that this amendment places the application in condition for allowance or better form for appeal by restricting the issues on appeal, and thus, entry of this amendment is respectfully requested under the provisions of 37 C.F.R. §1.116.

The Examiner is respectfully invited to telephone the undersigning attorney if there are any questions regarding this Amendment or this application.

Applicant does not acquiesce to any assertion made by the Examiner that is not specifically addressed herein.

The Assistant Commissioner is hereby authorized to charge payment of any additional fees associated with this communication or credit any overpayment to Deposit Account No. 500845.

Respectfully submitted,

Dated: 24 Jan 2005

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